12.0

Natural Groundwater Aquifer Recharge Element

Table of Contents

List of Tables

List of Figures

12.0 Natural Groundwater and Aquifer Recharge Element

12.1 Introduction

The potable water supply resources utilized by Monroe County including both the aquifer system and treatment facilities are geographically located in Dade County entirely outside of the County's jurisdiction (see Chapter 8.0, Potable Water). No new wells have been permitted in Monroe County since 1986 and therefore utilization of underground freshwater resources in the Keys as a potential potable water resource is not permitted. In Monroe County, the surficial aquifer is brackish to saline and contains an inadequate quantity of water for use as a potable water supply. The Florida Keys Aqueduct Authority (FKAA) is the agency that obtains and distributes potable water in the Keys. Currently, the FKAA is permitted by the South Florida Water Management District (SFWMD) to withdraw an average of 15.24 million gallons per day, not to exceed 5.56 billion gallons per year. The SFWMD consumptive use permit was granted in June 1990 and is authorized through 1995. Discussions of the potable water supply, permitting process and water treatment and distribution systems are presented in Chapter 8.0, Potable Water Element. As a result of the potable water source for Monroe County being located entirely within Dade County, aquifer protection related to the Florida Keys Aqueduct Authority's Florida City Wellfield is accomplished through the provisions of the Dade County Wellfield Ordinance. In Monroe County, groundwater resource protection and management takes place in the context of intense federal, state and private interest in natural systems as evidenced by the extensive amount of protected lands and waters.

12.2 Groundwater Aquifers and Recharge

Two sources of ground water underlie Monroe County - the Floridan Aquifer System, and the Biscayne Aquifer. Table 12.1 illustrates the relative positions and productivities of these hydrogeologic units.

The Floridan Aquifer System (FAS) is a confined artisan aquifer. In the Keys, wells tapping the FAS will flow at land surface at rates ranging from 75 to 1,000 gpm. Although available in significant quantities, Floridan water requires desalination treatment before it is suitable for either potable or irrigation use. Chloride concentrations in the FAS range from 1,600 to 20,000 mg/l, with concentrations generally increasing to the south. The Ocean Reef Club is the only consumer currently using enough Floridan Aquifer water to require an individual SFWMD permit.

The Biscayne Aquifer is the largest supplier of freshwater in southeast Florida. In the Keys, water from the Biscayne Aquifer ranges from brackish to chloride levels associated with seawater, and requires desalination for potable use. On some of the larger keys, a lens of freshwater floats above the saltwater. The largest of these freshwater lenses occur on Key West and Big Pine Key, but limited quantities also occur on Cudjoe and Sugarloaf Keys. Chloride levels in these lenses are too high for human consumption, but are suitable for most irrigation purposes and provide the major source of drinking water for wildlife. Some Monroe County residents provide their own water supply using home reverse osmosis (RO) plants to desalinate Biscayne Aquifer water, or collecting rain water in cisterns. However, due to the limited availability of fresh groundwater and its vulnerability to saltwater intrusion, and importance to wildlife, no additional wells have been permitted in the shallow aquifer since February 1986. The

primary source of water to the Keys is from the FKAA Florida City Wellfield, which pumps water from the Biscayne Aquifer in southeastern Dade County (Figure 12.1). The FKAA is the agency responsible for obtaining and delivering freshwater to the Keys. They treat the water in Florida City, then pipe it via aqueduct to Florida Keys residents.

Table 12.1 identifies water supply planning issues in the Florida Keys. The Surficial Aquifer System in the Keys does not contain water of sufficient quality and quantity to be considered as a viable freshwater supply. With the exception of desalination, water from the Florida City Wellfield in Dade County is the only source of potable water to the Keys. Contamination in the Florida City Wellfield would be a disaster for the Keys. Continued water quality monitoring, and appropriate management to prevent saltwater intrusion, are crucial to the protection of Monroe County's water supply.

Table 12.1
Groundwater Systems in Monroe County

Hydrogeologic System	Hydrogeologic Unit	Water Resource Potential
Surficial Aquifer System	Biscayne Aquifer	Largely saline, a lense of relatively freshwater floats above the saltwater on some of the larger keys. Must be desalinated for potable use. No additional withdrawals will be permitted. Vulnerable to spills and contamination.
Intermediate Confining Unit	Hawthorn Confining Beds	Very low permeability, continuing unit for the Floridan Aquifer System.
Floridian Aquifer System	Floridian Aquifer	Wells yield from 75 to 1,000 gallons of saline water per minute. Requires desalination for all uses. Some zones may be suitable for ASR applications.

Source: South Florida Water Management District, 1991

The amount of water stored in an aquifer is a function, in part, of water inflow, balanced against the water discharged from an aquifer. This discharge can take the form of either a naturally occurring flow from springs, lakes or wetlands, or in the form of wells. Should the water loss exceed the water inflow, water pressures between adjoining aquifers can be affected, and overdrafting, or overmining can occur, leading to an exchange of water between the aquifers.

Protection of the functions of natural groundwater aquifer recharge areas and natural drainage features is a legitimate goal because of the benefits associated with replenishment of water supplies such as: prevention of lateral movement of salt water from saline zones (known as saltwater intrusion); dilution of contaminants which could contribute to the degrading of the ambient water quality; reduction of surface flooding by providing storage; and prevention of sinkhole formation. The issue of water quality

protection must also be addressed because of the potential for recharge areas to receive contaminants and to transfer them to underlying aquifers.

12.3 Geology

The geologic units that are encountered in the Keys, in descending order from the surface, are: undifferentiated sands, the Miami Oolite, Key Largo Limestone, Tamiami Formation, Hawthorne Formation, Tampa Limestone, and Suwannee Limestone (Figure 12.1). The undifferentiated sands are of two types. The first are the Pamlico sands which were deposited during Pleistocene sea level changes. The second type are calcareous beach sands with minor amounts of true coral and shell which were deposited during recent time.

The Miami Oolite is found from Big Pine Key to Key West and is an offshore extension of the same formation found in southeast Florida. It was formed as a shoal deposit in warm shallow seas. Maximum thickness of the formation is forty feet with an average of twenty feet in the Keys. It is white to yellow in color and contains considerable fine to medium quartz sand that fills the solution holes. The Miami Oolite has many voids, thereby giving it a high porosity. However, there is little interconnection between the voids, causing it to have low permeability. This formation overlays the Key Largo Limestone in the southern Keys.

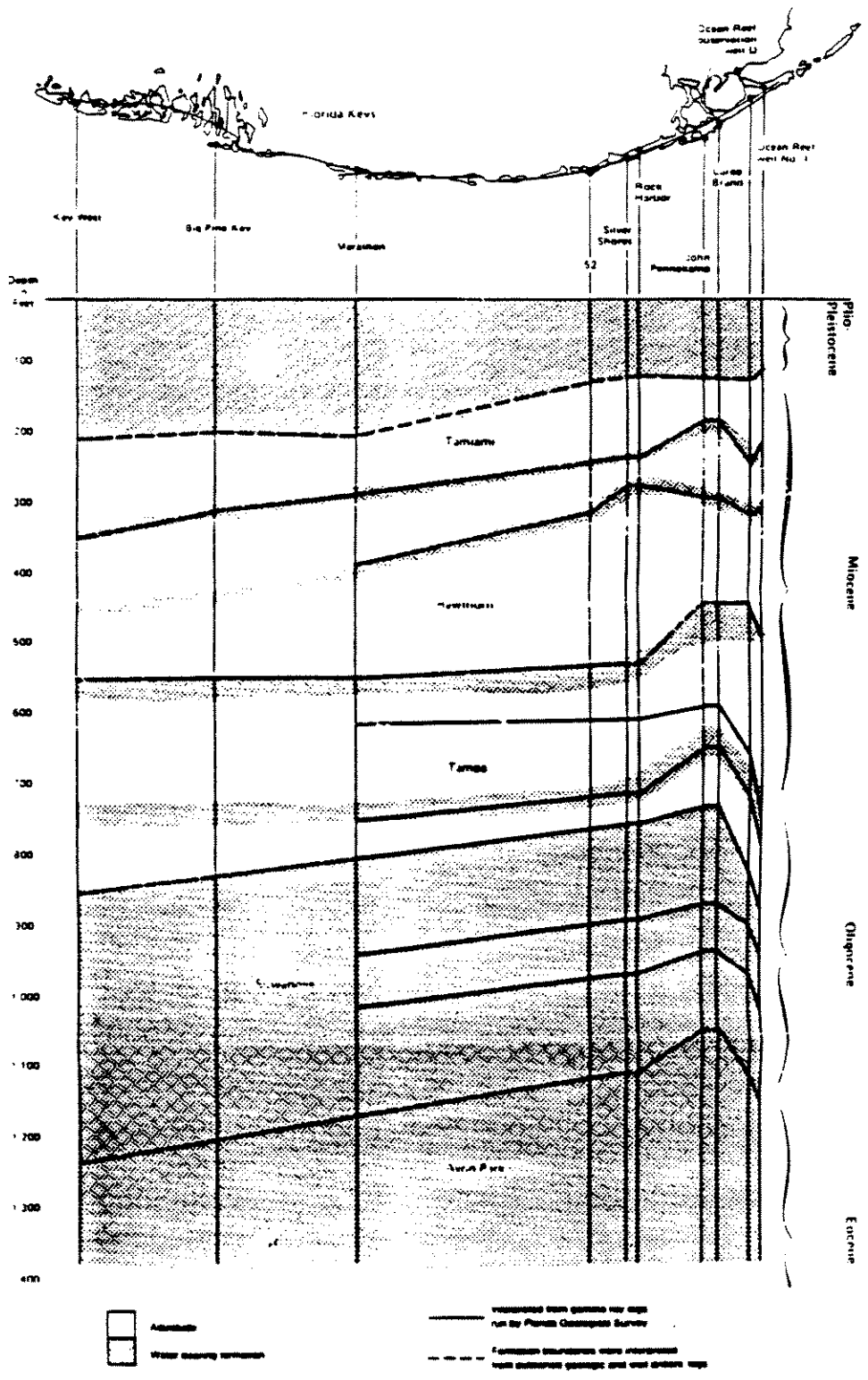
The Key Largo Limestone occurs at land surface from Soldier Key, off Miami, to Bahia Honda. It occurs as an ancient reef formation deposited during Pleistocene time. It averages sixty feet in thickness and is approximately ninety miles long, at land surface, by three miles wide (Parker, et. al., 1955). It is composed mainly of corals, amorphous limestone and detritus from wastage of the reef. The Key Largo Limestone contains cavities which make it very permeable. As a result, fresh water readily escapes to the sea, and ocean water easily enters the formation.

The Tamiami Formation underlies the Key Largo Limestone. It is predominantly a permeable sand with limestone lenses. It forms the lower part of the Biscayne Aquifer system, with the Miami Oolite and Key Largo Limestone forming the upper part, where the Keys freshwater lens systems are found.

The Hawthorne Group underlies the Biscayne Aquifer system and generally acts as a confining layer to the Floridan Aquifer System. It is relatively impermeable and consists of silt, clayey sand, and sand. It is phosphatic and greenish in color. Beneath Key Largo, this sequence is approximately 300 feet thick.

Underlying the Hawthorne Group is the Tampa Limestone. This formation consists of interbedded calcarenite (cemented sand-size grains of calcium carbonate) and calcilutite (flour-size grains). The calcarenite sequences contains abundant mollusk molds, giving it high moldic porosity and permeability. The Tampa Limestone is approximately 600 feet thick. Because of the alternating high and low permeability beds, this formation is considered a minor water-bearing zone of the Floridan Aquifer.

The Suwannee Limestone is considered a principal artisan water-bearing zone of the FAS. It consists of white, finely porous, chalky limestone composed chiefly of fragmental shells of bryozoa and foraminifera. In Key West, the formation is approximately 450 feet thick.



Source: Monroe County 201 Facilities Plan, 1979

KEITH and SCHNARS, P.A. ENGINEERS · PLANNERS · SURVEYORS	Monroe County Year 2010 Comprehensive Plan	Stratigraphy of the Florida Keys

Figure 12.1

12.4 Hydrogeology

The groundwater system underlying Monroe County is made up of two sources: the surficial or water table aquifer (Biscayne) and the FAS (see Figure 12.3).

In the Keys, both of these aquifers have chloride concentrations which exceed the drinking water criteria of 250 mg/l (U.S. Environmental Protection Agency, 1976). Therefore, in most cases, they can be used as a potable water source only after treatment of desalinization.

The Biscayne aquifer is considered an unconfined aquifer. In an unconfined aquifer, water levels are in equilibrium with atmospheric pressure. The upper boundary is termed the water table. The lower boundary is formed by a relatively impermeable bed. The Floridan Aquifer System is considered a confined or artisan system. An artisan aquifer is completely saturated and is bounded at the top and bottom by completely impermeable beds. The water level rises above the top of the confined aquifer in tightly-cased wells which are open only to the artisan aquifer.

12.5 Surficial Aquifer

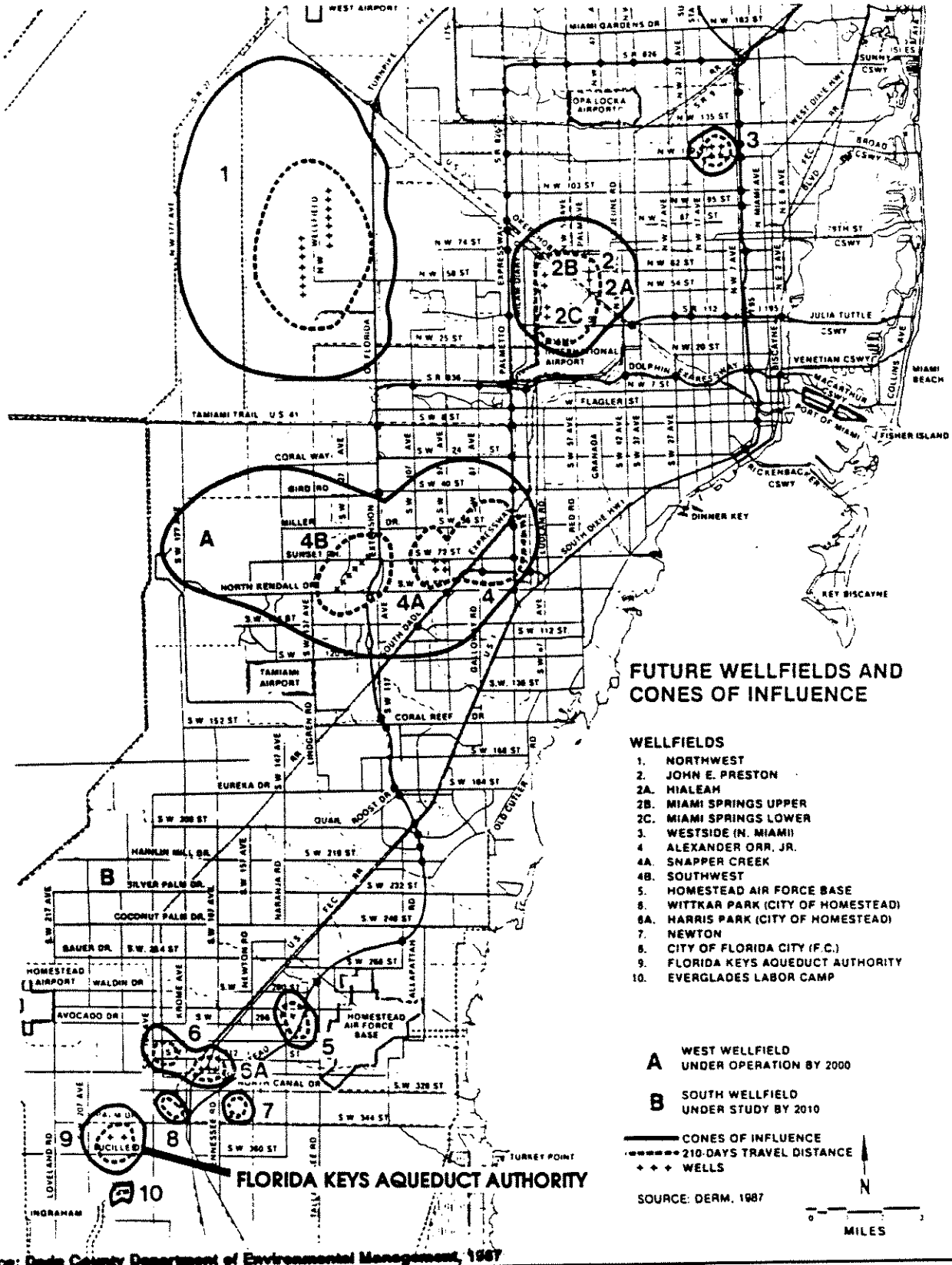
The Biscayne Aquifer, named after Biscayne Bay, is the source of the most important water supplies developed in southeastern Florida. It is the most productive of the shallow unconfined aquifers in the area and is one of the most permeable in the world (Parker, et al, 1955). In the Keys, the Biscayne aquifer is approximately 100 feet thick and includes the Miami Oolite, Key Largo Limestone, and the upper permeable portions of the Tamiami Formation. Under Broward and Dade Counties, the Biscayne Aquifer is a suitable potable water source. This water is piped via aqueduct to Florida Keys residents.

The quality and quantity of raw water in the Biscayne Aquifer is of paramount importance to regional supply. Aquifer recharge and water storage are the key components of maintaining an abundant water supply. The Biscayne Aquifer is recharged over its entire surface by rainfall. With much localized variation, the groundwater generally flows from the northwest to the southeast, so the wetlands areas both to the north and to the west of urbanized areas are critical natural recharge areas (see Figure 12.2).

A major difficulty with the raw water supply is not the average annual quantity of available water, but the seasonal variability in available quantity. Approximately 80 percent of the area's average annual rainfall occurs during the wet season from May to September.

Recharge and storage are managed by the SFWMD, an arm of state government. The regional water conveyance canals and water storage or Conservation Areas which are constructed by the U.S. Army Corps of Engineers with federal funds are operated and maintained by SFWMD. SFWMD also determines additional management and construction needs for the canal or groundwater system and regulates major water inputs and withdrawals which impact these systems. SFWMD's manages and operates its sophisticated network of floodgates, pumping stations, canals, levees, and Conservation Areas to maintain the delicate balance between flood and drought throughout the year. Wet seasonal rainfall stored in Lake Okeechobee and the Conservation Areas flows south to Dade County to aid in maintaining an adequate water table throughout the year.

The fresh and salt waters of the region come into contact along the coast. When stream flow and water tables are high, sea water is prevented for moving inland; when stream flow and water levels are low, sea



Source: Dade County Department of Environmental Management, 1987

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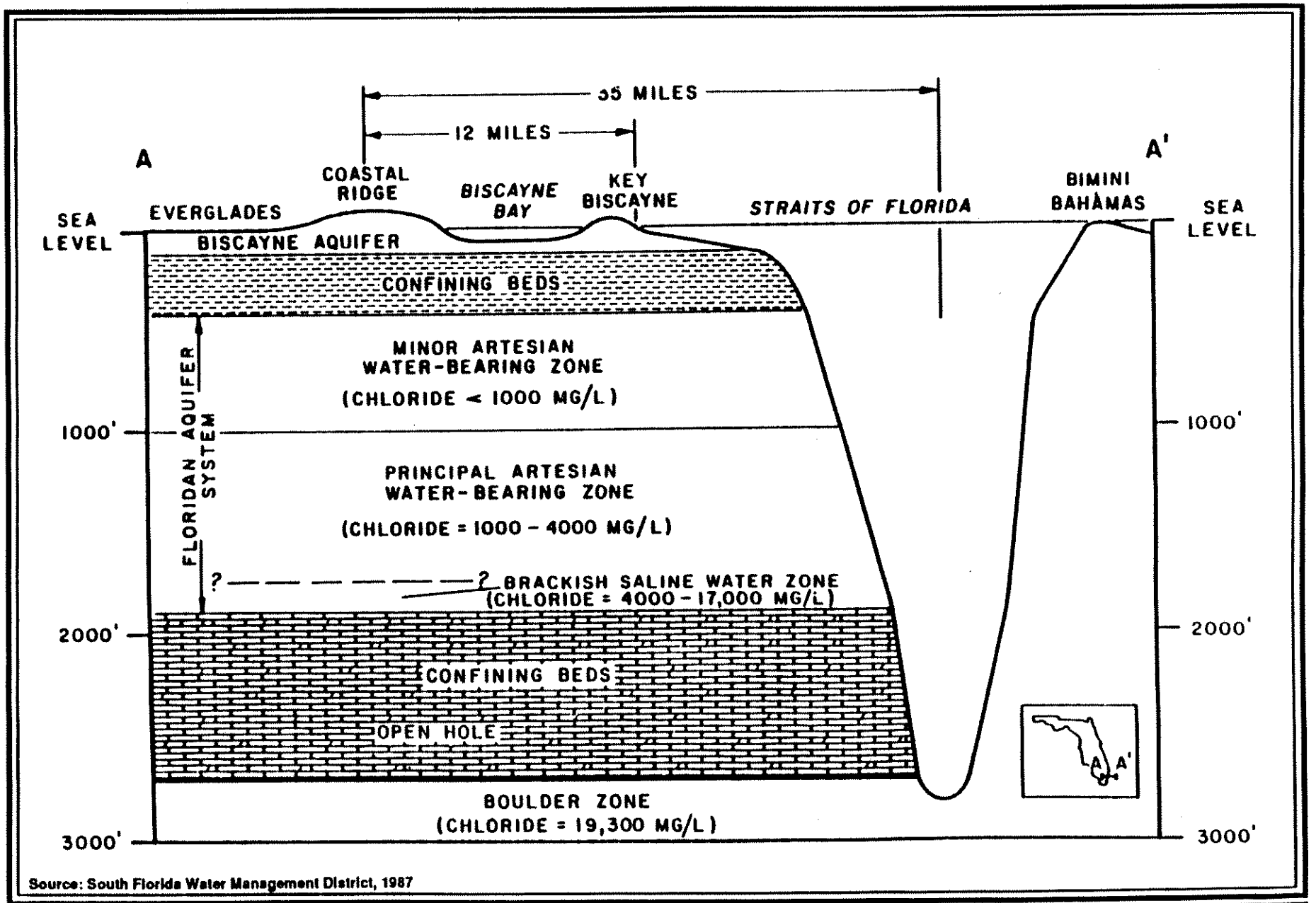
Figure 12.2



Source: South Florida Water Management District, 1987

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Year 2010
Comprehensive Plan

Generalized Cross-Section of South Florida Aquifers

Figure 12.3

water moves up tidal streams and into the aquifer, rendering the groundwater unpotable in coastal areas (see Figure 12.4). The progressive movement of the salt front inland has been halted by the South Florida Water Management District, but the salt intrusion problem is a constant threat in south Florida, especially in times of drought.

The direct connection between the ground and surface water systems makes the aquifer suspectable to pollution and disruption from urban activities at the land surface. Many contaminants are rapidly diluted in the large volumes of water contained in the aquifer, and the porous limestone acts as a filter. However, high concentration of pollutants can overload and incapacitate the aquifer's natural cleansing action.

On some of the larger keys, a thin lens of freshwater floats on top of the salt water. The size of the lens is dependent on rainfall, evapotranspiration, groundwater losses to the sea and pumpage (Hanson, 1980). Key West and Big Pine Key contain the largest quantities of fresh water (Parker et al, 1955). Limited quantities also occur on Cudjoe, Sugarloaf, and other Keys. The chloride concentrations are too high for potable use, but the water is used for irrigation and domestic consumptive uses. Irrigation wells have to be very shallow because chloride concentrations increase rapidly with depth. On Big Pine Key, only the upper fifteen feet of the aquifer contained water suitable for irrigation (Hanson, 1980).

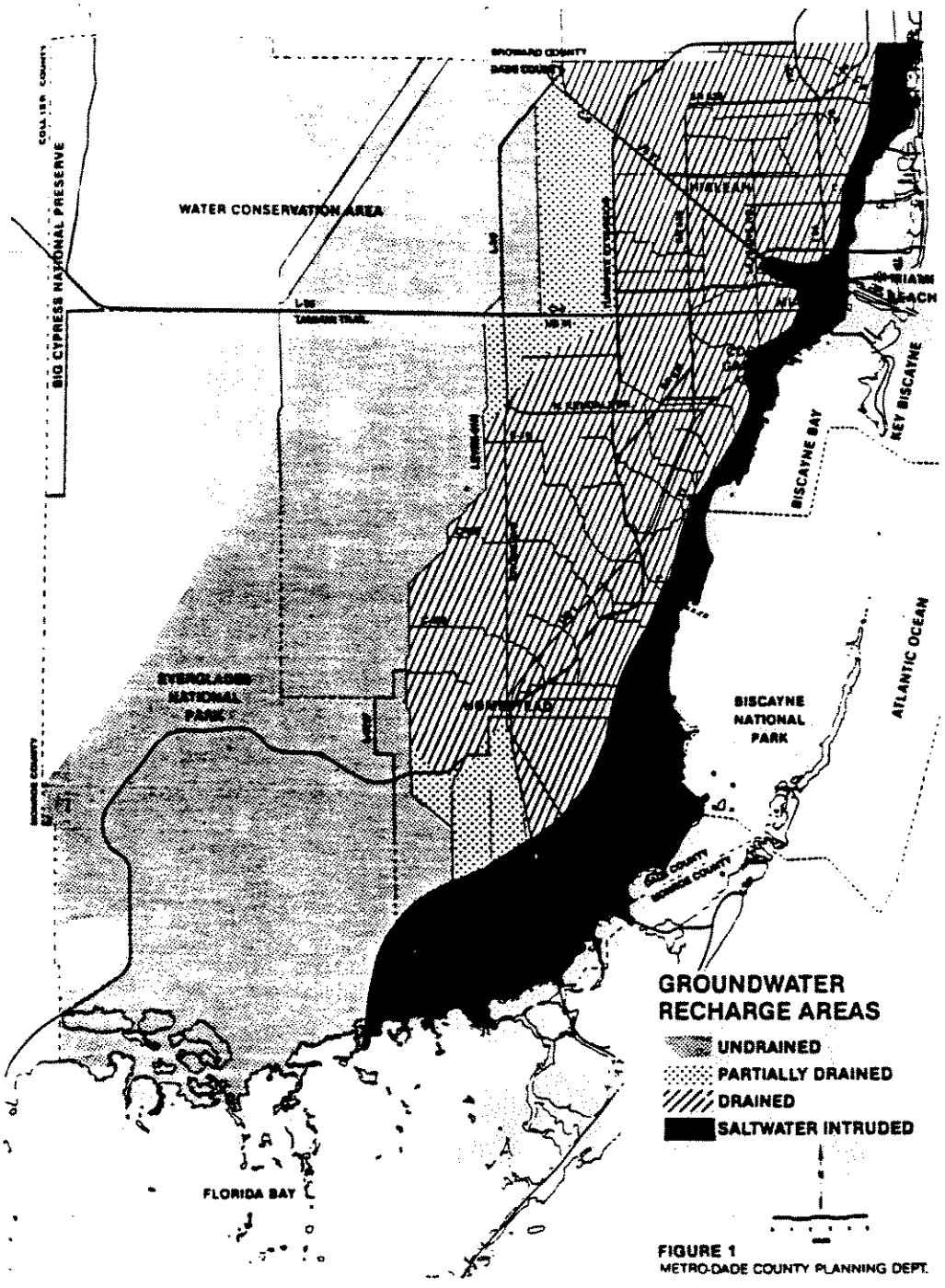
There are many potential sources of contamination to the freshwater lens system because of its high permeability.

In the Florida Keys, the lens is not recognized as a source of potable water supply and therefore is not subject to potable supply regulations. The main source of contamination is saltwater intrusion which can be caused by overpumping or drought.

12.6 Floridan Aquifer

The FAS underlies all of Florida and parts of the adjacent states of Georgia and Alabama. In Dade County it occurs at about 900 feet below sea level (Parker, et al, 1955). It consists of a 1,500-foot thick series of artisan water-bearing zones within the Tampa and Suwannee Limestones. The FAS is confined above by the Hawthorne Group and below by less permeable limestone and dolomite units. In December 1975, the static head in the Floridan aquifer ranged from 38 to 41 feet above mean sea level in Key Largo (Beaven and Meyer, 1978). This means that wells into the FAS in the Keys range form 75 gpm (gallons per minute) to more than 1,000 gpm, with 750 gpm being the average. Flow rates depend upon the amount of penetration into aquifer and the types of sediments encountered (Parker, et al, 1955).

The FAS is the best source of raw water for large desalinization operations because it has low chloride levels. The water in the FAS has potential as a source of supply for public and industrial purposes after desalinization. Chloride concentrations in the Floridan aquifer range from 1,600 mg/l (brackish) to 20,000 mg/l (saline). High chloride concentrations are due to the occurrence of relict seawater and distance from the source of primary recharge (Polk and Lake Counties). Chloride and dissolved solid concentrations are major considerations when determining the cost effectiveness of a desalinization process (Lapointe and O'Connell, 1989). Water from the upper portion of the FAS (brackish zone) could provide raw water for treatment at reasonable cost for large-scale municipal and industrial supply. The FAS does not outcrop or receive direct recharge anywhere in South Florida. Therefore, there is no potential for contamination from surface sources. Concern does exist, however, that large withdrawals



Source: Metro Dade County Planning Department, 1987

KEITH and SCHNARS, P.A. ENGINEERS · PLANNERS · SURVEYORS	Monroe County Year 2010 Comprehensive Plan	Ground Water Recharge Areas	Figure 12.4

from the Floridan Aquifer could cause upwelling or encroachment of saline water which in turn would increase production costs for current and future reverse osmosis/desalinization plants.

12.7 Freshwater Lens Condition

Mapping of the freshwater lens systems in the Keys has been a subject of interest and some study in recent years. Mapping has been made somewhat easier by the use of surface geophysical techniques (measuring conductivity) rather than drilling wells for testing. The National Audubon Society is currently carrying out further mapping efforts in the Keys as part of ongoing research. For the most part, past studies have focused on Big Pine Key only.

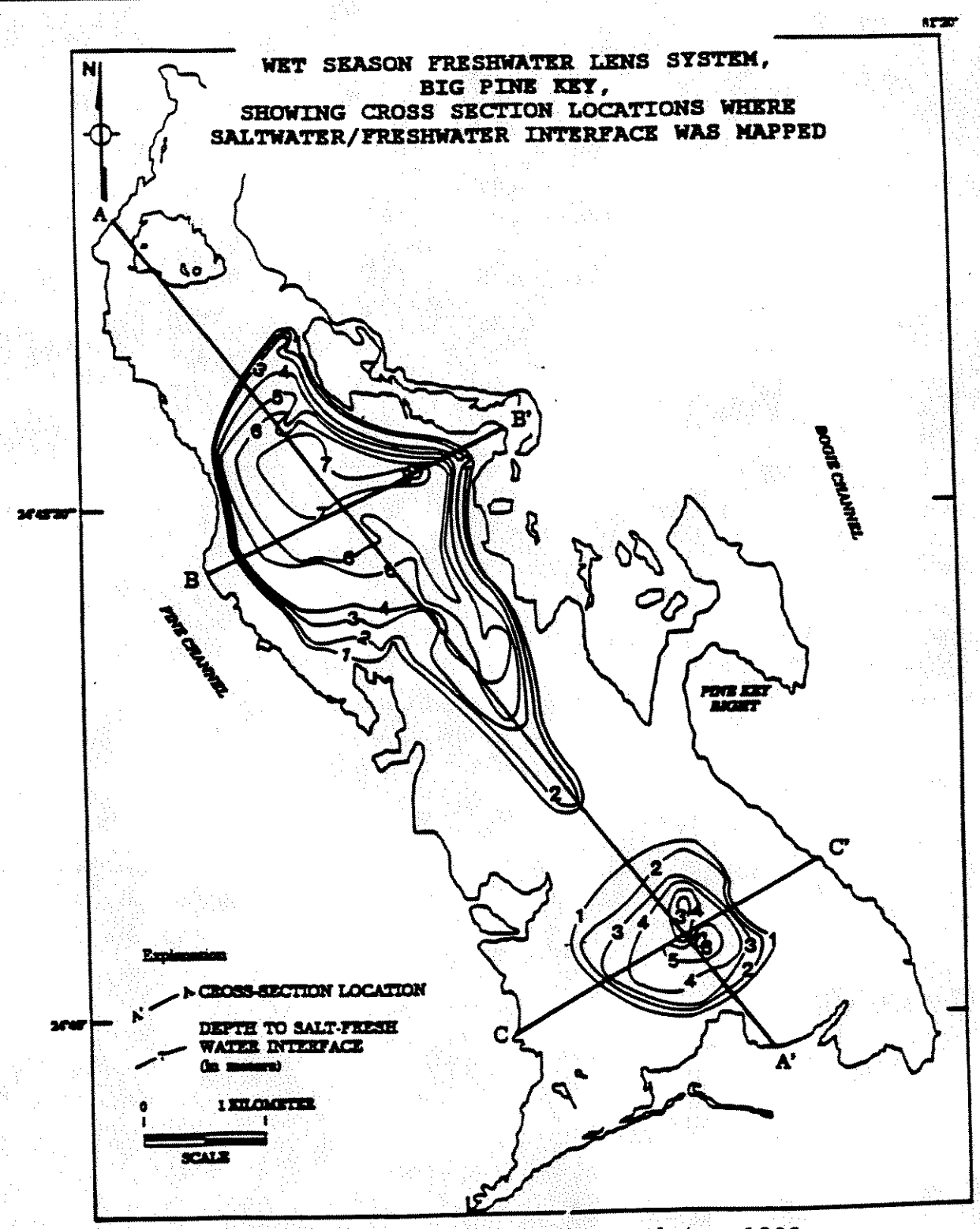
Hanson's study (1980) of the fresh water on Big Pine Key found that continued pumping from shallow wells would probably not damage the system. However, he projected that future increased withdrawals from new residences and new or enlarged plant nurseries would "increase the stress on the freshwater lens which can only supply moderate amounts without detrimental effects during most years". Indeed, recent investigation shows that, a decade later, the effects of urbanization are being exhibited by the freshwater lens (Stewart, Wightman, and Beaudoin, 1989). The southeast lens on the Key has decreased in lateral extent and maximum depth and is clearly affected by saltwater intrusion due to pumping and dredging activities as illustrated in Figures 12.5 and 12.6. The current National Audubon Society study may provide some information on the effect of rising sea levels on the freshwater lenses and vegetative communities in the Keys. Although past shrinkage of the lens probably cannot be reversed, maintenance of the existing lens may be accomplished by preventing additional withdrawals and providing for maximum maintenance of recharge sources.

12.7.1 Freshwater Lens Pollution and Water Quality

The surficial aquifer is directly recharged by rainfall and has the greatest potential for contamination from surface sources. Sources of contamination can be divided between point sources and nonpoint sources. A "point source" is defined as any discernible, confined and discrete facility that discharges pollution. Landfills, impoundments, gasoline stations and septage disposal are examples of point sources which can contaminate the groundwater aquifers.

The three regulated landfills located on Key Largo, Cudjoe Key and Long Key are possible point sources of contamination, and therefore, have monitoring systems to detect leachate migration to the surficial aquifer.

Septic tanks are another potential source of contamination. Because the aquifer is very permeable, effluent moves easily through the drainfield and can migrate off site. Septic tank effluent characteristically contains bacteria including fecal coliform and fecal streptococcus as well as other various virus and chemical pollutants. This could pose public health concerns for those households using well water for consumptive uses such as bathing. The regulation of septic tank effluent with relation to groundwater and surface water quality is discussed in more detail in Chapter 10.0 (Sanitary Sewer Element). Other pollution sources include pesticides for mosquito spraying and oil baths for lobster traps.



Source: Stewart, Wightman, and Beaudoin, 1989.

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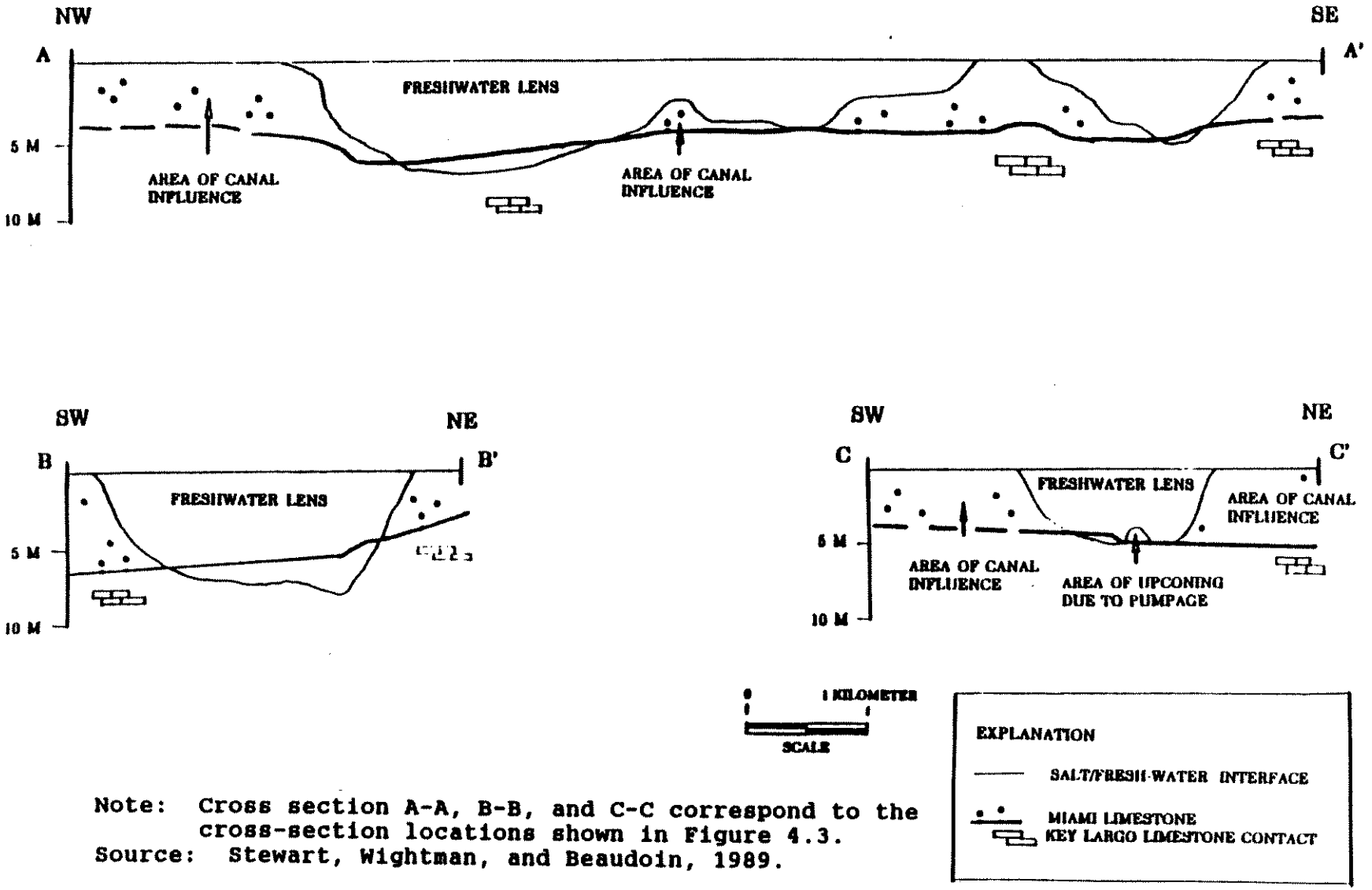
Wet Season
Fresh Water Lens
System, Big Pine Key

Figure
12.5



Note: Cross section A-A, B-B, and C-C correspond to the cross-section locations shown in Figure 4.3.
Source: Stewart, Wightman, and Beaudoin, 1989.

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Year 2010
Comprehensive Plan

Saltwater/Freshwater Lens Interface in the Wet Season

Figure 12.6

Nonpoint sources are any discernible sources of pollution not associated with point sources. They are more pervasive and less controllable sources of pollution. Storm runoff from urban areas is an example of nonpoint pollution which affects both ground and surface water. Typical components of nonpoint source pollution are those contaminants resulting from the application of substances or the weathering of substances associated with urban development. Oils and greases, trace metals, pesticides, herbicides and nutrients can be expected to emanate from urbanized areas. Treatment systems for these pollutants typically consist of holding areas to attenuate runoff. As such, these areas may contribute pollutant loads to the surficial aquifer. It is, nevertheless, believed that the risk to the surficial aquifer is less than the risk to surface waters from direct discharge of runoff.

12.8 Regulatory Framework

The overall intent of federal and state regulation of groundwater aquifers is the protection of public drinking water supplies from contamination. The protection of water table levels and the regulation of aquifer withdrawals are primarily under the domain of the SFWMD, while water quality is regulated by the Florida Department of Environmental Regulation (DER). These agencies may also be involved in the preservation of freshwater resources in general where they are not used for mass public consumption, but the effective regulation of these resources are carried out mainly at the local government level.

12.8.1 Federal Regulations

U.S. Public Law 93-523, "Safe Drinking Water Act" was enacted on December 16, 1974, for the purpose of implementing a nationwide system of monitoring and controlling the quality of water supplied by public water systems. The Environmental Protection Agency (EPA) was given authority to administer the Act. In addition, the Act also required EPA to develop criteria for selecting critical aquifer protection areas. The program calls for state and local governments to map those areas and develop protection plans, subject to EPA review and approval. Once a plan is approved, EPA may enter into an agreement with the local government to implement the plan.

The Safe Drinking Water Act provides for the protection of public water system wellfields and aquifers used as the sole source of a community drinking water supply. Amendments provide for wellfield protection which require states to work with local governments through the planning process to identify and to protect wellhead areas. Although the aquifer protection amendments require the EPA to develop criteria for selecting critical aquifer protection areas, the criteria have not yet been developed.

12.8.2 State Regulations

Department of Environmental Regulation Rules within Chapter 403, F.S., "Florida Safe Drinking Water Act," and Chapter 17-22, Part III, F.A.C., classify and regulate the use of aquifers. The DER has also developed increasingly stringent regulatory requirements for facilities which discharge to groundwater under Section 17-4.245, F.A.C., and for those facilities which inject materials underground through deep well injection. Groundwater quality standards are included in Chapter 17-3, F.A.C., with Florida Keys groundwater generally falling under Class G-III criteria. These criteria mainly set standards for protection of public health in general and the protection of natural systems from toxic substances, but nutrients are not addressed.

Chapter 163, Florida Statutes, the "Local Government Comprehensive Planning and Land Development Regulation Act of 1985", requires local government comprehensive plans to include a topographic map depicting the prime groundwater recharge areas for the Floridan and Biscayne Aquifers, as designated by local water management districts. The designation of prime recharge areas is required by Chapter 373, F.S. However, there is no definition or criteria given for designation and, to date, this task has not been done. It can be assumed that any Monroe County designations would be on the mainland portion of the county since they apply only to the Biscayne and Floridan Aquifers.

12.8.4 Local Regulations

At the present time, Monroe County has no special regulatory programs related to protection of natural groundwater aquifer recharge areas, nor has there been any comprehensive identification of these areas. While Chapter 380, F.S., does express concern for preservation of freshwater wetlands for wildlife, the only specific regulation directly affecting groundwater is the prohibition of well excavation in "high quality pineland" areas. Existing local regulations presently affecting ground water pollution sources are mainly limited to those addressing stormwater runoff. There is presently no set limit on impervious surface coverage for development, as long as all stormwater is handled on site. Monroe County recently revised its stormwater management criteria in the draft Stormwater Management Ordinance which is presently undergoing review for inclusion in the Land Development Regulations (see Chapter 11.0, Drainage Element). The ordinance, however, does not encourage the use of natural drainage patterns or protection of recharge areas or functions.

While contamination of the freshwater lens may not be an immediate threat to public health, it could affect the environment which contributes to the economy of the Keys, and thus indirectly affect its residents. Saltwater intrusion is of primary concern since shrinkage of a given lens system could result. As mentioned, state regulations concerning groundwater quality do not address nutrients, yet a high rate of flow exchange between groundwaters and surface waters (Lapointe and O'Connell, 1989) may carry groundwater nutrients to surface waters, where the state does regulate them. Surface water quality is addressed in Chapter 3.0 (Conservation and Coastal Management Element).

12.8.5 Aquifer and Aquifer Recharge Area Protection

The following discussion is excerpted from the SFWMD, Draft Water Supply Policy Documents, April 1991, and describes the measures utilized to meet the state directive to preserve and enhance the quality of the state's ground and surface waters.

Generally, water quality standards in Florida are developed by the State of Florida Department of Environmental Regulation (DER) and adopted by the Environmental Regulatory Commission. DER is charged with enforcing the standards, although it may delegate some of its authority to the District or other governmental units. Other regulatory authority, such as the land use/zoning powers of local government, directly impact water quality, and the SFWMD has established a program to address water resource concerns related to land use and other comprehensive plan issues.

The permitting programs of the SFWMD and the DER achieve their joint goal through different mechanisms. The DER's statutory authority and regulatory program for protection of the state's water quality addresses discharges into the waters of the state. This program is distinguished from the SFWMD regulatory water use program which addresses withdrawals from surface and ground water sources. The

SFWMD program protects the quality of the state's water resources (primarily related to the movement of constituents). Decisions in this program can cause discharge of pollutants into the water resources through the transport of pollutants in "used" water.

The SFWMD consumptive use permitting program regulates quality issues associated with water withdrawals by evaluating the potential for a withdrawal to cause the following impacts:

(a) saltwater intrusion;
(b) upconing of saline water;
(c) movement of other (non-salt) pollutant sources;
(d) spread of contamination from a point or non-point source through expansion of a cone of depression;
(e) changes in the hydroperiod and impacts in the natural treatment capacity; and
(f) interaquifer exchange associated with well construction.

The SFWMD also requires well plugging pursuant to Chapter 373.207, F.S., to prevent the movement of saline water into freshwater aquifers.

The SFWMD uses DER's water quality standards and water body classifications to determine the water quality status of aquifer and surface waters. The SFWMD will recommend to DER new standards (including site-specific alternative criteria) or classifications as necessary to protect the water resources of the state.

In the development of Surface Water Improvement and Management (SWIM) plans, water supply plans for specific geographic subregions, and other planning documents, the SFWMD may identify areas and water bodies for which additional protection is necessary. The development of such water quality guidelines or caps will be done in coordination with DER. The SFWMD will continue to develop or support initiatives such as the wellfield protection programs to assist local governments in linking water quality with land use decisions. The SFWMD SWIM process will identify, recommend and implement solutions for water quality problems within specific priority water bodies.

A. Ground Water

The SFWMD may allow movement of lower quality water into a higher quality aquifer to occur only in limited, defined circumstances when the use is necessary for maximum reasonable-beneficial use and is consistent with the DER ground water classification. To achieve water quality protection and enhancement in these situations, it is recommended that the regional water supply plans establish boundaries and recommend water quality-caps beyond which a use may not degrade an aquifer, as consistent with state water quality standards.

As a corollary, the SFWMD regional water supply plans may establish areas of water quality which, on a local or regional level, may have already exceeded the recommended limits. In these instances, the District may apply regulatory means of enhancing water quality, to the extent possible, to meet the specified water quality requirements of the defined area. However, SFWMD caps will not allow degradation of a source to a point which exceeds the DER classification for the water body. The SFWMD will encourage linkage of the proposed groundwater boundaries and caps with local government land use decisions similar to wellfield protection ordinances with the intent that local governments make

land use decisions based on potential aquifer development as consistent with the water quality protection and enhancement goal.

B. Surface Water

As a function of updating the SFWMD's Basis of Review, which includes the SFWMD's rules governing the issuance of consumptive use permits, two surface water issues should be addressed. These issues are related to the protection and enhancement of the quality of water resulting from withdrawals from a surface water source and discharges of withdrawn water to surface water bodies.

Two surface water classification systems are proposed for the SFWMD regulatory system:

(a) Non-degradable surface water bodies. The SFWMD will follow the guidance in the DER's rules concerning anti-degradation.

(b) All other surface water bodies would be subject to use restrictions applicable to ground waters. Thus, no withdrawal from a surface water source may occur which causes water quality degradation beyond those limits established for the water body. A balancing of water quality concerns and reasonable-beneficial uses will result in water quality degradation occurring in these limited, defined circumstances.

12.8.6 Florida City Wellfield

The FKAA wellfield is located just west of Florida City and consists of nine operational wells (Figure 12.7). Rated capacity for each well is 3 mgd except for Well No. 4, which is rated at 2 mgd. Each well extends into the Biscayne Aquifer, which serves as the primary raw water source. Raw water quality at the FKAA wellfield has historically been acceptable for potable water supply. Water quality data included in the permit modification application indicated that the water is hard and low in turbidity, color and iron. Review of the data for the 1989 application indicated that water quality had changed little if any as a result of current withdrawals. No percolation ponds, hazardous or toxic waste disposal sites, sewer mains, saline water bodies or wastewater treatment facilities are located within a one mile radius of the wellfield. The FKAA wellfield is currently protected by the Dade County Wellfield Protection Ordinance which is administered by the Department of Environmental and Resource Management (DERM).

A condition of the permit requires FKAA to monitor and submit data from the Salt Water Intrusion Monitoring (SWIM) program to the District on a monthly basis. In accordance with an additional condition of the permit FKAA is implementing a Saline Water Intrusion Monitoring Program (SALT) which utilizes 6 monitoring wells to measure any movement of the saline water interface. The SFWMD criteria to prevent saltwater intrusion is that one-foot head of fresh water be maintained between the wellfield and the saline water source. Saltwater intrusion usually results from a sustained decrease in fresh water head, allowing saltwater to migrate inland. Results of groundwater modeling indicate that drawdowns associated with increased withdrawals are minimal. The FKAA in cooperation with the United States Geologic Survey (USGS) maintains a ground and surface water quality monitoring network around the wellfield that is sampled monthly. The network consists of three wells with continuous water level recorders, three canal sampling points, and six monitor wells. From the data included in the 1989 Application for Water Use Permit Modification it was concluded that the 1000 mg/L isochlor is estimated to be 4 to 5 miles southeast of the well field in approximately the same location reported in 1974.

12.8.7 Wellfield Protection

In 1983, the Florida Department of Environmental Regulation (FDER) began developing a wellhead protection program to prevent contamination of public water supplies. The program known as the G1-Rule is based on groundwater quality, a five year travel time contour and a calculated radius of protection. Since its adoption, the G1-Rule has been challenged in court and as a consequence has not been successfully implemented. However, FDER encourages and supports local governments to take the lead in protecting their drinking water supplies and is assisting the Department of Community Affairs with related comprehensive planning.

For Dade County, Wellfield Protection planning began in the late 1970s. The Wellfield Protection Program is based on the need to protect the drinking water resources from potential contamination and the delineation of prohibitive or protection zones. These zones are as follows:

Zone 1: land within the 100' boundary around wells

Zone 2: land between the 100' boundary and the 10-day travel time contour.

Zone 3: land between the 10-day and 30-day travel time contours.

Zone 4: land between the 30-day and 100-day travel time contours.

Zone 5: land between the 30-day and 210-day travel time contours.

Zone 6: one foot drawdown based on average permitted pumping day.

Zone 7: one foot drawdown based on maximum permitted pumping day.

Examples of Dade's Wellfield Protection Restrictions are provided in Tables 12.2 and 12.3.

12.8.8 Freshwater Lens Resources

The freshwater lens systems of the Florida Keys are considered to be critical to the support of the existing wildlife and plant communities in these areas. There is a need for continued efforts towards mapping these systems and monitoring their condition, including size and water quality. Protection of the lens systems should be accomplished through regulation of withdrawals and of land use in recharge and wetland areas. Of particular concern are: freshwater withdrawals for private consumptive uses, loss of recharge areas to impervious surface coverage, and contamination of groundwater from surface sources and salt water intrusion.

It has been demonstrated that the freshwater lens on Big Pine Key has suffered some reduction from its former size. While droughts and sea level rise may be contributors to this phenomenon, it cannot be disputed that freshwater withdrawals have their effect on the lens. New dredge and fill projects

Table 12.2
Land Use Regulations for Regional Wellfield Protection and How The Regulations are Implemented

LAND USE REGULATIONS	HOW IMPLEMENTED
No new activities involving hazardous materials are allowed within Wellfield Protection Areas of the Northwest and West Wellfields and within the basic protection area for all other wellfields, (excluding public utilities, rockmining, pre-packaged haz. mats. for domestic use, & agriculture)	No BU-3 or IU zoning allowed in West and Northwest Wellfields, IW-6 and AW-6 permitting programs inspect all non-residential activities to ensure that no use conversions involve hazardous materials
No new non-residential activities except on sewers	DERM plans review process
BU-3 and IU zoning prohibited	Wellfield Zoning Overlay Ordinance for West and Northwest
Regulate existing uses handling hazardous materials	Grandfathering and restrictive covenants Reducing risks with operating permits No expansion unless demonstrate decreased risk of contamination
Expedited sewering of unsewered areas	Creation of Special Taxing Districts and prioritization of unsewered areas
Limiting residential density to reduce sewage loading for both septic tank and sewer	Zoning rollbacks and zoning overlay, DERM plan review
Zoning variances require 4/5 vote from Zoning Appeals Board	Zoning hearing and appeals process is more stringent than for outside of wellfield areas
Removal or retrofitting of existing underground storage tanks	Storage tank permitting program and DERM plan review
Stringent stormwater disposal requirements and improved municipal system maintenance	DERM plans review and creation of Stormwater Utility
Prohibit pipelines transporting hazardous materials	DERM plans review process
Rockmining restricted but promoted as an acceptable land use	DERM plans review process

Source: Dade County DERM

Table 12.3
Urban Wellfields Land Use Restrictions and Prohibitions for New Construction

	PROTECTION ZONES							
ACTIVITY	100'	10 DAYS	30 DAYS	100 DAYS	210 DAYS	AVERAGE DAY	MAXIMUM DAY	OUTSIDE
NON-RESIDENTIAL USES HANDLING HAZARDOUS MATERIALS PROHIBITED	YES	YES	YES	YES	YES	NO* Haz. Waste Prohibited	NO*	NO*
EXISTING USES HANDLING HAZ. MAT. MUST REDUCE RISK UPON EXPANSION	YES	YES	YES	YES	YES	NO*	NO*	NO*
NON-RESIDENTIAL USES SERVED BY SEPTIC TANKS RESTRICTED	YES Prohibited	YES	YES	YES	YES	NO*	NO*	NO*
RESIDENTIAL USES SERVED BY SEWERS RESTRICTED	YES Prohibited	YES 2.4 units/acre	YES 4.6 units/acre	NO*	NO*	NO*	NO*	NO*
NON-RESIDENTIAL USES SERVED BY SEWERS RESTRICTED	YES Prohibited	YES	YES	NO*	NO*	NO*	NO*	NO*
SEWER CONSTRUCTION CRITERIA MORE STRINGENT	YES	YES	YES	YES	YES	YES	YES	NO*
STORMWATER DISPOSAL RESTRICTED	YES Prohibited	YES Infiltra-tion only	YES Infiltra-tion & seepage only	YES Infiltra., seepage,or overflow outfall	NO*	NO*	NO*	NO*
ROCKMINING RESTRICTED AND SECURITY MEASURES REQUIRED WHERE ROCKMINING IS ALLOWED	YES Prohibited	YES Prohibited	YES Prohibited	YES 40ft. max. depth or 30 day travel time buffer and land dedication		NO*	NO*	NO*
LAKE CONSTRUCTION WITHIN 1/4 MILE OF LANDFILLS PROHIBITED	YES	YES	YES	YES	YES	YES	YES	YES
UNDERGROUND STORAGE TANKS FOR HAZARDOUS MATERIALS RESTRICTED	YES Prohibited	YES Prohibited	YES Prohibited	YES Prohibited	YES Prohibited	NO* 2nd cont.	NO* required	NO*

	PROTECTION ZONES							
ACTIVITY	100'	10 DAYS	30 DAYS	100 DAYS	210 DAYS	AVERAGE DAY	MAXIMUM DAY	OUTSIDE
PIPELINES TRANSPORTING HAZARDOUS MATERIALS PROHIBITED	YES	YES	YES	YES	YES	NO*	NO*	NO*
LIQUID WASTE STORAGE, TREATMENT OR DISPOSAL METHODS OTHER THAN SEPTIC TANKS & PUBLIC SANITARY SEWERS RESTRICTED	YES Prohibited	YES Prohibited	YES Prohibited	YES Non-contact cooling water only	YES Non-contact cool. water and other effluent seepage only.	NO*	NO*	NO*

*No additional restrictions, county-wide restrictions may apply. Protection zones:

10-210 days (estimated pollutant travel times in days)
Average day (average day permitted pumpage, 1ft. drawdown)
Maximum day (maximum day permitted pumpage, 1ft. drawdown)

Source: Dade County Department of Environmental Management, 1990

are largely prohibited in the Keys both by state and local governments. Further increases in private consumptive withdrawals should not be permitted and alternative water sources are needed.

While the current draft Stormwater Management Ordinance does address the need to handle stormwater on site, it does not stress the need to retain natural drainage features and reduce impervious surfaces. Well drained uplands are the most active recharge areas, and also are under increased development pressure relative to wetlands. Standards are needed which will insure minimum coverage of recharge areas with impervious surfaces and minimum loss of runoff to ponding and evaporation before recharge can occur. Acquisition of important recharge areas may also be an option for preservation.

The County already implements regulations that serve the purpose of protecting the freshwater lens recharge areas. Mining can pose a threat to recharge areas. Therefore, the County prohibits any resource extraction activity that would cause the introduction of saline aquifer waters into fresh water aquifers, and also prohibits excavation below 60 feet (Section 9.5-432, LDRs.)

In addition, a habitat analysis is required for any proposed development in slash pine lands or tropical hardwood hammock. Since pineland habitat is an indicator of freshwater lens recharge areas, the County now requires a relatively high open space ratio in these areas. In high-quality pinelands, 80% of the property must remain as open space. For low-quality pinelands 60% must remain open space.

The County also requires on-site retention of stormwater, which helps the fresh water filter into the ground and eventually into the freshwater lenses, instead of draining to lower ground where it would more likely evaporate or drain into the ocean.

In order to further protect the recharge areas the County will:

(a) Adopt a new Stormwater Management Ordinance, which will provide clarification on where and how various stormwater retention techniques are to be used. (See Section 11.6, Drainage Element and related policies.)

(b) Produce a Best Management Practices manual for public distribution that explains stormwater management practices in layman's terms. (See Section 11.6, Drainage Element and related policies.)

(c) Coordinate with the USFWS and SFWMD to map and evaluate the freshwater lenses and recharge areas that have not yet been mapped. This information will then be entered into the County's Geographic Information System. As part of the evaluation, the effects of scarification will be considered. SFWMD has recently moved the Florida Keys area to a higher priority on its list of Surface Water Improvement and Management (SWIM) Plans it intends to complete. The lenses and recharge areas should be mapped before or as part of the SWIM Plan.

(d) Upon completion of the mapping, the County will consider altering the open space ratios & other development regulations for these areas.

(e) In the meantime, the County will continue to require the open space ratios.

(f) Prohibit limestone mining within or adjacent to any seasonal or permanent freshwater lens or lens recharge area, and/or restrict the depth of excavations in these areas (See the Conservation & Coastal Management Element, Section 3.3, and Policy 208.3.2.)

(g) Phase out the use of all water wells in the unincorporated County.

(h) Within the County's acquisition efforts as part of the new Natural Heritage and Park Program, the County will consider freshwater lenses and recharge areas, especially those which overlap the habitats of endangered or threatened wildlife species, as a high priority. (See the Future Land Use Element Section 2.4.1.G, and Objective 102.4 and related policies.)

(i) As part of the Stormwater Master Plan, assess the amount and types of pollution found within stormwater, and the effect of this pollution on the freshwater lenses & recharge areas. (See Drainage Objective 1001.3 and related policies.)

(j) Consider assigning a negative point rating to developments proposed within the recharge area of freshwater lenses.

(k) The regulation of contaminants which are toxic or are a public health hazard are probably adequately regulated by existing state standards. However, due to the high permeability of these lens systems in connection with surface waters, other pollutants may be a problem. Continued monitoring and regulation should be carried out according to a comprehensive water quality monitoring program for the County.

12.8.9 South Florida Water Management District Water Conservation Policy Guidelines

The Water Resources Act of 1972 formally designated the conservation of water as a key policy of the state and mandated that state and regional water resource agencies take steps to prohibit wasteful and unreasonable uses of the state's water supply. For South Florida, the adoption of the act also thrust the SFWMD into a lead role in water supply planning and regulation.

Water conservation is a high priority in SFWMD policy and DER rules, in keeping with the statutory mandate. One of the key concept in any attempt to match water supply and demand is to avoid wasting the available supply. Florida law provides that wasteful uses are not protected, which in effect mandates conservation and demand management measures be taken to protect the available resource from waste or abuse.

In order to maximize the reasonable and beneficial uses of water, the SFWMD will develop and implement demand management criteria District-wide, and focus its implementation on areas of critical water concern. These areas of critical concern will be defined in the water supply plans, and special criteria for mandatory demand management in these areas will be established considering the following issues:

(a) economics of implementation;
(b) existing and projected demands by source classification (potable versus non-potable); and
(c) availability of source(s) for a specific level of service.

Implementation of the demand management program will be both passive (public information) and active (retrofitting, permit requirements for irrigation efficiencies, model landscape codes, etc). Development of the critical areas rules will proceed simultaneously with this development of this document.

As part of its efforts to conserve freshwater resources in areas of high demand, the SFWMD will continue to analyze and support the development of alternative water sources such as desalinization, reverse osmosis and wastewater reuse. Also, as noted below, the SFWMD will continue to investigate and support other supply augmentation alternatives. The development of other supply sources, however, does not lessen the requirements for conservation and efficient water uses. As discussed below, inefficient or wasteful uses of water are not considered reasonable or beneficial, as required by law for all legal uses.

A related concept found in Florida's water use policy is the use of the lowest quality water available and appropriate for a specific use. This policy, for example, encourages the replacement of high quality ground water with treated wastewater for irrigation purposes if a feasible source is available. The effect of this policy is to optimize the utilization of available resources by requiring diversification of sources. The SFWMD is required by Chapter 17-40, F.A.C., to designate areas of critical water supply concern. These areas have or will experience water supply problems in the next 20 years. Re-use will be required in such areas in accordance with SFWMD criteria. During the past decade, the use of potable water for lawn and landscape irrigation has drawn extensive attention, and has been the focus of numerous conservation campaigns. These efforts have included water shortage awareness campaigns and xeriscape (low-irrigation landscaping) programs.

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